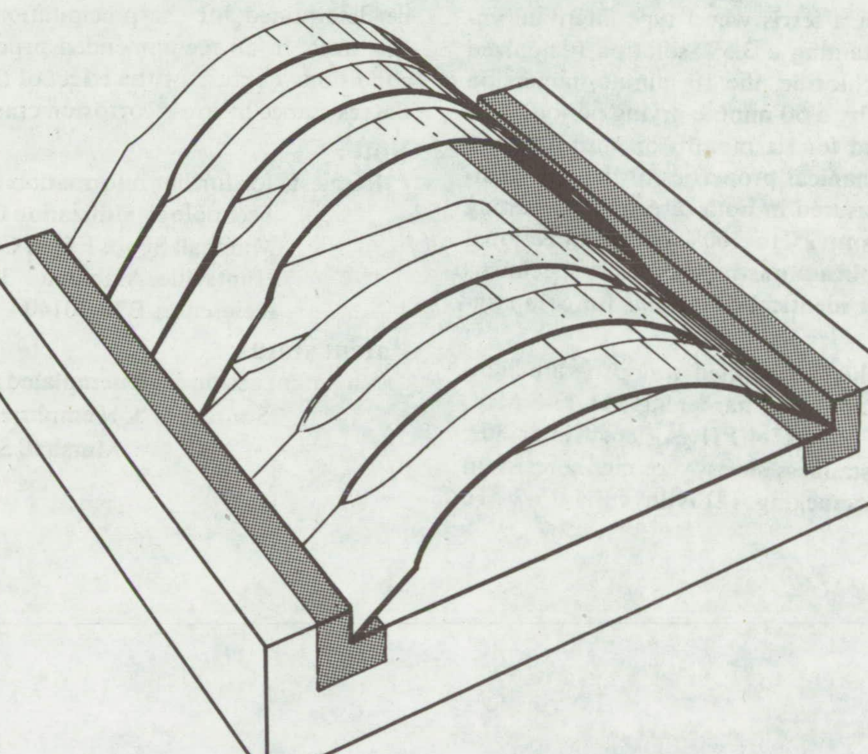
NASA TECH BRIEF

Stress Corrosion Cracking Evaluation of Precipitation-Hardening Stainless Steel



Flat Tensile Specimens Loaded in a Constant Span Fixture

Precipitation-hardening (PH) stainless steels, such as the hardenable chromium stainless steels, under conditions of tensile stress and a corrosive environment suffer stress corrosion. As with most metals, the stress corrosion cracking susceptibility normally increases with increasing hardness or strength. However, the stress corrosion susceptibility is not governed solely by hardness or strength of the material, but it appears to be associated with the processes used to obtain the desired material characteristics. Because of the limited amount of available test data, a program was initiated to evaluate the stress corrosion resistance of the more frequently used PH stainless steels in a corrosive environment.

(continued overleaf)

The PH stainless steels evaluated in this investigation were PH 13-8 Mo, PH 14-8 Mo, 15-5 PH, PH 15-7 Mo, 17-4 PH, 17-7 PH, A-286, Almar 362, AM-350, and Unitemp 212 in the form of bar stock and/or sheet. Three types of specimens were required to test the material in at least two directions of grain orientation. Flat tensile specimens, loaded by constant deflection, were used for testing sheet material; round tensile specimens, stressed in direct tension, were used for testing the longitudinal direction of all bar stock and the transverse direction of two inch or greater diameter bar; and C-rings, utilizing the constant deflection method, were used for testing the transverse direction of bar stock of less than two inch diameter.

The specimens were deflected or strained the calculated amount in order to reach the desired stress levels (see Fig.). After undergoing a cleaning cycle, they were placed in a ferris wheel type alternate immersion tester containing a 3.5% solution (deionized water) of sodium chloride; the 10 minute immersion cycle was followed by a 50 minute drying period. This test phase continued for six months or until a failure occurred. The mechanical properties of the PH stainless steels were measured in both directions of testing at a stress level from 25 to 100% of the directional yield strength. Duplicate unstressed tensile specimens were exposed under identical conditions for comparative control.

The results of this accelerated test program indicated: (1) The precipitation hardening PH 13-8 Mo, PH 14-8 Mo, 15-5 PH, 17-4 PH, A-286, Almar 362, and Unitemp 212 stainless steels were highly resistant to stress corrosion cracking. (2) Alloys PH 15-7 Mo and 17-7 PH were susceptible to stress corrosion cracking in all heat treat conditions tested except Ch 900, and AM-350 was resistant in Condition SCT 1000 but susceptible in Condition SCT 850. (3) Precipitation hardening stainless steels appeared to be less resistant to stress corrosion cracking in the transverse direction of grain orientation than in the longitudinal direction. (4) The stress corrosion cracking susceptibility of the precipitation hardening stainless steels generally increased with increasing hardness or strength, but in certain cases appeared to be associated with the process procedure used to obtain these properties. Alloy 17-7 PH stainless steel exhibited the highest resistance to stress corrosion cracking in Condition CH 900, and this condition gave the highest hardness and strength of any of the conditions tested.

The stress corrosion cracking resistance should be determined for the precipitation hardening stainless steels in all recommended process and heat treat conditions because of the effect of these conditions on the resistance to stress corrosion cracking.

Note:

Requests for further information may be directed to:

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Reference: B70-10140

Patent status:

No patent action is contemplated by NASA.

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(MFS-20667)